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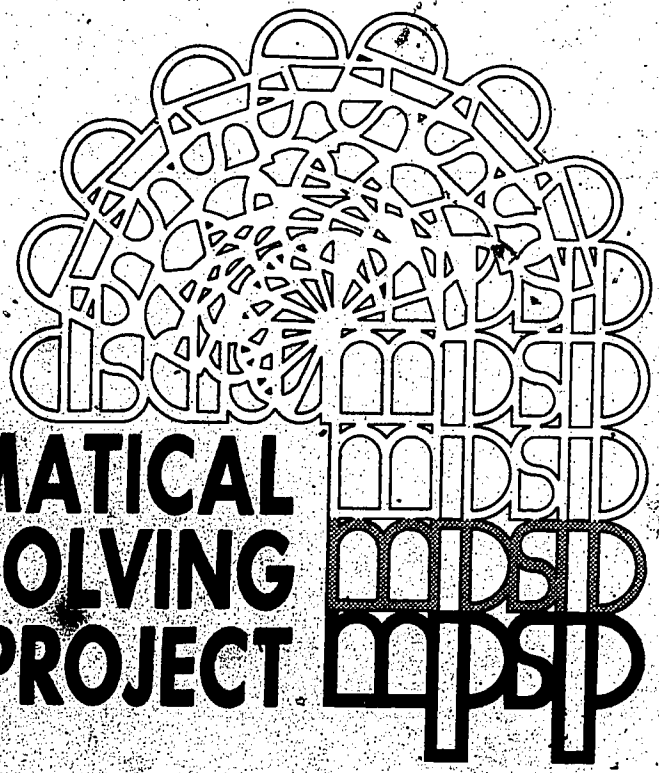
ABSTRACT

One of the implicit goals of the Mathematical Problem Solving Project, MPSP, was to increase the teachers' awareness of what problem-solving is and of different ways of solving problems. The problem solving sort task was developed to assess change due to involvement with MPSP in the teachers' perception of what problems they would use to teach problem solving and which problems they felt their students would be interested in solving. Instrument development, administration, analysis, and results are given and conclusions stated. (MP)



MATHEMATICAL PROBLEM SOLVING PROJECT

A Project of the
MATHEMATICS EDUCATION DEVELOPMENT CENTER

Project Supported by
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FINAL REPORT
MATHEMATICAL PROBLEM SOLVING PROJECT
TECHNICAL REPORT VI:
REPORT ON THE PROBLEM SORT TASKS FOR TEACHERS

Report Prepared By

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May 1977

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TECHNICAL REPORT VI

Report on the Problem Sort Tasks for Teachers

Norman L. Webb

The major focus of the Mathematical Problem Solving Project was on the problem-solving performance of children. Problem-solving performance is affected by many factors, with the teacher being one of the more important ones. One of the implicit goals of the project was to increase the teachers' awareness of what problem solving is and of different ways of solving problems. It was felt that involvement with the MPSP materials would have an impact on the teachers' view of appropriate kinds of problems to do with children and on the teachers' view of what kinds of problems children would enjoy doing. So the problem-solving sort task was developed to assess changes in the teachers' perception of what problems they would use to teach problem solving and which problems they felt their students would be interested in solving.

Instrument Development

Appendix A describes how the sort tasks were administered, the categorization scheme used to group problems, the two forms (T1 and T2) completed by the teachers, and the three problem decks, one for each grade level. Briefly, three problem decks, one for each of grades 4, 5, and 6, were formed, each containing 24 problems. The problems in each deck were selected to represent six categories based on the processes used to solve the problem.

The categories are:

1) Computation and/or algorithmic problems,
2) Standard word problems directly translatable into number sentences,
3) Standard word problems not directly translatable into number sentences, or requiring a combination of compiled information,

4) Problems requiring several steps not readily implied in the problem statement,

5) Problems requiring a combination of a generalization of information (For some of these problems multiple solutions exist. For some not all of the conditions are overtly stated.),

6) Applied or project problems requiring data to be collected and evaluated in order to derive a solution ("real-world" situations).

For each problem deck, four problems were included from each category. The 24 problems were randomly distributed within each deck.

Administration

Each teacher was given a problem deck for the appropriate grade level and asked to select those problems (s)he felt her/his students would like to solve (Form T2). The sort task was administered two times, once as a pretest in June 1975 and once as a post-test in May 1976. For the purpose of analyses, the project teachers were separated into two groups:

Teachers who had participated in the project during 1974-75 school year (Group 11)

Teachers joining the project in 1975-76 (Groups 12 or 13)

At the time of the post-test nine control teachers were also given the two sort tasks. These teachers had given their students the pre-post tests for the summative evaluation but had not used any of the MPSP instructional materials.

Analysis

The percent of problems selected by the teachers for each form, T1 and T2, was computed by category. The percent was calculated by dividing the number of problems selected by the teachers in the group

by the total possible number of problems in the group (that is by 4). Only project teachers who took both the pre- and post-tests were included in the analyses.

Results

Figures in Appendix B show the results for both sort tasks. A summary of the results is given below:

Form T1: Would Use in Teaching Problem Solving. Teacher Group 11, second-year teachers, had small changes over the year. This is not surprising since these teachers had already had a full year of involvement in MPSP prior to the pretest. The biggest changes were in categories 5 and 6, process and application problems. The Group 11 teachers would use fewer of these problems in teaching problem solving at the end of the year than at the beginning. Teacher Group 11, as compared with the control group, would use fewer of the computation/algorithmic problems and more of the process application problems as evidenced on both the pretest and the post-test. The crossover point was category 3, word problems not directly translatable into number sentences.

Teacher Groups 12 and 13, teachers who were new to MPSP at pretest time, had sizeable change in all categories except categories 3 and 6. At the end of the year these teachers would use in teaching problem solving fewer problems from categories 1 and 2 and more problems from categories 4 and 5 than they would have at the beginning of the year. The crossover point was category 3. Comparing teachers from Groups 12 and 13 with control teachers, the control teachers would use more problems from categories 1 (computation) and 4 (process) than would the project teachers on the post-test. The project teachers would use more problems from categories 2 and 5. Teachers in Groups 12 and 13

would use a wider range of types of problems than control teachers. These project teachers selected over 70 percent of the problems in categories 2, 3, 4, and 5.

Form T2: Children Would Be Interested in Solving. Teachers in Group 11 selected fewer problems in all categories on the post-test than they did on the pretest. Teachers in Groups 12 and 13 had small changes in the percentage of problems selected between the pretest and post-test. After being exposed to the MPSP materials they felt children would be interested in solving fewer of the same type problems, categories 1, 2, 6, and more of problems in categories 4 and 5. The control group differed from both of the groups, which had generally parabolic shaped curves and had in general a decreasing curve. The control teachers felt children would be interested in solving more of the problems in categories 1 and 2 and fewer of the problems in categories 4, 5, and 6 and about the same on category 3 as the project teachers.

Conclusions

The category of problems most emphasized by the MPSP instructional materials are the process problems, categories 4 and 5. The perception of the teachers (Groups 12 and 13) who were new to MPSP in June 1975 did change to using more of these problems and fewer of the computational/algorithmic problems in teaching problem solving. The second-year teachers lost some enthusiasm for (or maybe became more realistic about) the process problems (category 5) but still selected more than the control teachers. The trend suggests that the teachers associated with the project did change in their perception and were after a year or two still interested in using the process-type problems in teaching problem solving. This information by itself is not particularly

meaningful. Teachers may just have learned to recognize which type of problems the project was concerned with. But comments by the teachers such as those below do suggest that what teachers think about problem solving and teaching for problem solving did change. Below are comments made by some teachers at the final teacher interview:

--I have learned to like math more because of the problem decks. I intend to use the materials in the future.

--I can see the importance of some things.

--I have learned from the materials and will incorporate problem solving in math even if materials are not available.

--My perception (of problem solving) has changed. I had not thought of using a list. I learned along with the kids and became a little more lenient.

--I did not see as much change in the kids as in myself. I was locked in about solving problems. The program gave me an understanding that there are different approaches to solving problems. I didn't think other people were solving problems in other ways and that I should introduce these ways to the children. It has awakened me to other avenues of presenting this kind of materials so the child can find his or her own method of solving the problems. Where before, if they did not pick up my method, they didn't get it.

--I feel the knowledge of how to use a table is much more useful than other math learning such as dividing fractions. When do I ever use this? Making a table and concepts of making a list are much more defendable.

With these comments and the results from the sort tasks, teachers who participated in the project did change in their perception of problems

they would use to teach problem solving. The percent of problems teachers felt that children would be interested in solving did deteriorate some, particularly for teachers who had been associated with the project for two years. For the one-year teachers, their perception of what children would be interested in did not change greatly over the year.

APPENDIX A

Teacher Problem Sort Task

Instruction for the Administration of the
Problem Sort Task T1 and T2 for Teachers

Problem Selection

Forms T1 and T2

Problem Decks to Accompany Forms T1 and T2
Grade 4, Grade 5 and Grade 6

MPSP

June 12, 1975

Instruction for the Administration of the Problem Sort Task T1 and T2 for Teachers

MATERIALS NEEDED:

MPSP Form T1 -- one for each teacher
MPSP Form T2 -- one for each teacher
Problem Deck IV -- one for each fourth grade teacher
Problem Deck V -- one for each fifth grade teacher
Problem Deck VI -- one for each sixth grade teacher

ADMINISTRATION:

Form T1

Give each teacher Form T1 and one of the three problem decks, IV, problems for fourth grade teachers, V, problems for fifth grade teachers, and VI, for sixth grade teachers. The IV, V, or VI set is indicated by a IV, V, or VI respectively, in the lower right corner for each problem. Be sure each teacher records his or her name and the grade level (s)he teaches at the top of the form. The teachers can read the instructions to themselves on the top of Form T1 and then begin sorting the problems. Be sure they understand that they are to circle the problem numbers of the problems they would include under each heading. They are to put each problem in one of the two categories according to which category best represents their feelings about the problem.

For the sort task T1, the teachers are asked to select problems that they would use in teaching problem solving. How they may use the problem is up to them. We are interested in, according to their perception of problem solving, would they use the problem to teach problem solving to their students. For instance, the teacher may want to use the problem but wants to break the problem down into smaller steps. This teacher would then circle the problem number in the "would use" column.

Some teachers may consider changing a few words in the problem before they would use the problem. If by changing these words the spirit or meaning of the problem is changed, then they should circle the problem number under the "would not use" column. If the changing of the words would not change the meaning of the problem, then the problem number under the "would use" column should be circled.

Form T2

Give each teacher Form T2 and one of the three problem decks, IV, problems for fourth grade teachers, V, problems for fifth grade teachers, and VI, for sixth grade teachers. Follow the same instructions used for Form T1.

For the sort task T2, the teachers are asked to sort the problems according to whether or not the students in their class would be interested in solving the problems. The teachers are to consider the problems from their students' point of view. If the teacher feels that some of their students would be interested in solving the problem and some would not, circle the problem number in the column which would represent how the greater number of his or her students would respond.

PROBLEM SELECTION:

There are three sets of problems, one at the fourth grade level, one at the fifth grade level, and one at the sixth grade level. Some problems are included in two or three of the sets. Each set of problems contains a range of problems selected to represent a variance in problem-solving processes from computation and using algorithms to collecting and synthesizing necessary information to derive a solution. Six categories were identified to group the problems. Each set of problems contains four problems in each category. The categories are:

1. Computation and/or algorithmic problems.
2. Standard word problems directly translatable into number sentences.
3. Standard word problems which require a combination of computed information or which are not directly translatable into number sentences.

4. Problems which require several steps which are not readily implied from the problem statement.

5. Problems which require a combination and a generalization of information to solve. For some of these problems multiple solutions exist. For some not all of the conditions are overtly stated.

6. Applied or project problems which require data to be collected and evaluated in order to derive a solution. These problems are related to "real world" situations.

These six categories are not sacred. A more realistic categorization may be to have four categories:

1. Computation (1 above)
2. Textbook word problems (2 and 3 above)
3. Process-recreational problems (4 and 5 above)
4. Real world problems (6 above).

The problems in each problem deck were classified as follows:

Problem Deck IV

Problem Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Category	1	5	2	6	1	2	2	6	1	5	2	3	6	1	4	5	3	4	6	4	3	5	4	3

Problem Deck V

Problem Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Category	1	3	2	5	4	1	2	5	4	6	3	6	4	5	3	2	6	5	3	2	1	4	6	1

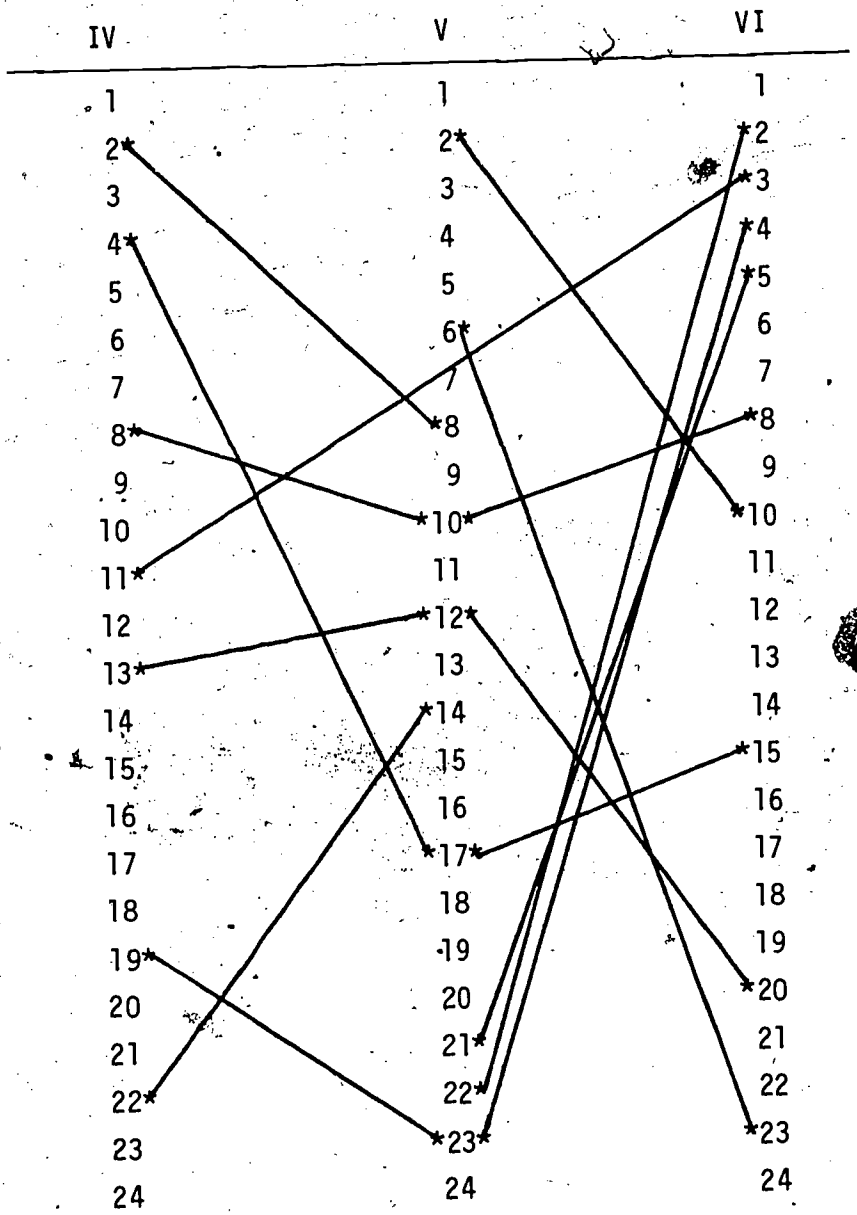
Problem Deck VI

Problem Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Category	1	4	2	6	1	5	2	6	5	3	5	3	2	1	6	2	3	4	3	6	4	5	1	4

T1 & T2 Problem Decks

June 12, 1975

SAME PROBLEMS BETWEEN DECKS



MPSP

Form T1

6/75

Name: _____ Teaching Grade Level: _____

Sort the problems into the two categories:

"WOULD USE IN TEACHING PROBLEM SOLVING"

"WOULD NOT USE IN TEACHING PROBLEM SOLVING"

Make your choices on the basis of the appropriateness of the problem for problem-solving instruction in your class. Circle the problem numbers in the appropriate column to indicate your choices.

WOULD USE IN TEACHING PROBLEM SOLVING			WOULD NOT USE IN TEACHING PROBLEM SOLVING		
1.	9.	17.	1.	9.	17.
2.	10.	18.	2.	10.	18.
3.	11.	19.	3.	11.	19.
4.	12.	20.	4.	12.	20.
5.	13.	21.	5.	13.	21.
6.	14.	22.	6.	14.	22.
7.	15.	23.	7.	15.	23.
8.	16.	24.	8.	16.	24.

MPSP

Form T2

6/75

Name: _____ Teaching Grade Level: _____

Sort the problems into the two categories:

"CHILDREN WOULD BE INTERESTED IN SOLVING"

"CHILDREN WOULD NOT BE INTERESTED IN SOLVING"

Make your choices based on the children in your class. Circle the problem numbers in the appropriate column to indicate your choices.

CHILDREN WOULD BE INTERESTED IN SOLVING			CHILDREN WOULD NOT BE INTERESTED IN SOLVING		
1.	9.	17.	1.	9.	17.
2.	10.	18.	2.	10.	18.
3.	11.	19.	3.	11.	19.
4.	12.	20.	4.	12.	20.
5.	13.	21.	5.	13.	21.
6.	14.	22.	6.	14.	22.
7.	15.	23.	7.	15.	23.
8.	16.	24.	8.	16.	24.

MPSP

PROBLEM DECK TO ACCOMPANY FORMS T1 AND T2

GRADE LEVEL 4

1. Find the difference.

(A) 53 − 37

(B) 176 − 42

(C) 204 − 197

IV

2. Last night I watched a little league baseball game. I noticed some boys and dogs playing in the grass. I heard a noise and looked to see the boys and dogs running past me. I decided to count them in a different way. I counted the legs and found there were 40 of them. Now, what I want to know is how many boys and how many dogs ran past me?

3. Mother baked 12 cookies. Three children shared the cookies. How many cookies did each child get?

IV

4. As a group project find the best answer to this situation. Your section of town has 1000 people living in it. Estimate how much water (in gallons) is used by these people in one day (24 hours). Design a water tower to hold this one-day supply of water. Decide upon the shape (spherical, cylindrical, or something) and figure out the size.

5. Find the quotients.

(A) $64 \div 8$
(B) $40 \div 5$
(C) $42 \div 7$
(D) $72 \div 9$

IV

6. 2 basketball teams.
5 players on each team.
How many players?

7. Susan had 57 pictures for her new album. She put 6 pictures on each page.

(A) How many full pages did she get?

(B) How many pictures were left over for the last page?

IV

8. Suppose that you have a supply of 5¢ and 8¢ stamps. What amounts of postage (less than $1) can be obtained using these stamps?

9. Find the products.

(A)	(B)	(C)	(D)
4	4	6	5
x 4	x 5	x 2	x 5

IV

10. I have 6 pockets in my clothing.
I have 81¢ in change - 5 dimes, 5 nickels, and 6 pennies. I'd like to put these 16 coins in my pockets with a different number of coins in each pocket. Can I do this?

11. Frank started with a number and multiplied it by 7. Then he added 75, subtracted 75 and divided by 7. Frank's answer was 19. What did Frank start with?

IV

12. Study the first four equations. Then solve the last one.

$$(1 \times 9) + 2 = 11$$
$$(12 \times 9) + 3 = 111$$
$$(123 \times 9) + 4 = 1111$$
$$(1234 \times 9) + 5 = 11{,}111$$
$$(12{,}345 \times 9) + 6 =$$

13. As a group project find the best answer to this situation. You are organizing a tour from New York City to Washington D.C. for your club of 100 members. You have a choice of four ways to go, private cars holding five passengers each, busses holding 50 passengers each, a two-car commuter train holding 100 passengers, and a 100 passenger airplane. You want to conserve energy so you want to select the means using the least fuel. How should you travel?

IV

14. The numbers given in the chart are the childrens' scores for each game. For example, Dan scored 47 points in game 3.

	Ann	Bill	Carol	Dan
game 1	28	27	62	81
game 2	34	26	58	27
game 3	39	43	72	47
game 4	50	76	40	56
game 5	63	18	43	64
game 6	31	71	42	54

(A) Who had the highest score in game 5?

(B) Who had the lowest score in game 1?

(C) Who had a score of 40?

(D) In game 2, how many points did Carol and Dan score together?

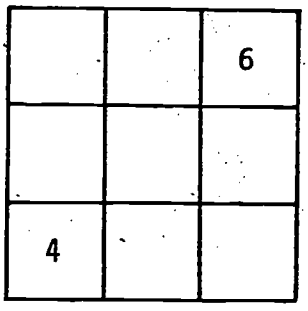
VI A-14

IV

15. Fifteen couples were going to go to a birthday party. Small tables that can seat one person on a side are going to be put together to make a long table.
How many tables will be needed to seat exactly the 30 people who are coming to the party?

IV

16. We call a 3 x 3 checkerboard a magic square if once you put in the right numbers, each row, each column, and each diagonal will add up to 15. Use each number from 1 to 9 one time and fill in the small squares.

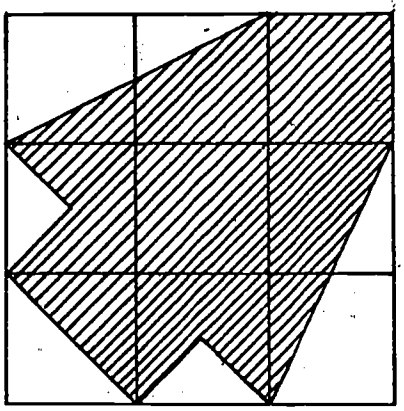


VI A-15

17. Jack had twice as much money as Betty. When Jack gave Betty 5¢, they had the same amount. How much did Jack start with?

IV

18. Find the area of the shaded part.



19. Your class has decided to produce a play. Before the play can be performed lines need to be learned, rehearsals held, scenery designed and produced, and costumes designed and produced. Some of these activities can be performed at the same time, but some must be performed before other activities can be done. The cast can learn the lines at the same time costumes and scenery are being designed. The costumes and scenery must be designed before either one of these can be produced. The production of the scenery and learning the lines must be done before rehearsals. The production of scenery and costumes can take place at the same time. The times needed for the various activities are:

Activity	Days
learn lines	5
design costumes and scenery	3
produce scenery	3
produce costumes	5
rehearsals	4

What is the shortest time after the play is selected that it can be performed?

IV

20. How many segments of different lengths can be drawn between 7 points in a straight line?

21. Brian's father weighs 100 pounds more than Brian. Together they weigh 240 pounds. How much does Brian weigh?

IV

22. There are 5 cups on the table. John has 9 marbles, and he wants to put a different number of marbles under each cup. Can he do this? Explain.

23. A bank truck had an accident and spilled 300,400 pennies on the highway. How high would these these pennies stack up? How long a line would the pennies make?

IV

24. Bob had 2 tickets for rides at the carnival. There were 4 things he could ride: the merry-go-round, ferris wheel, airplanes, roller coaster.

(A) Give all the ways Bob could use his 2 tickets. There are 16 ways.

(B) Write a multiplication equation about this.

MPSP

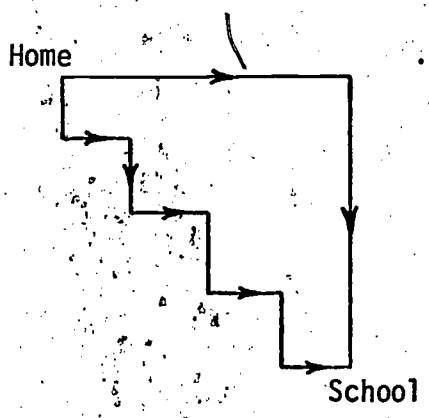
PROBLEM DECK TO ACCOMPANY FORMS

T1 AND T2

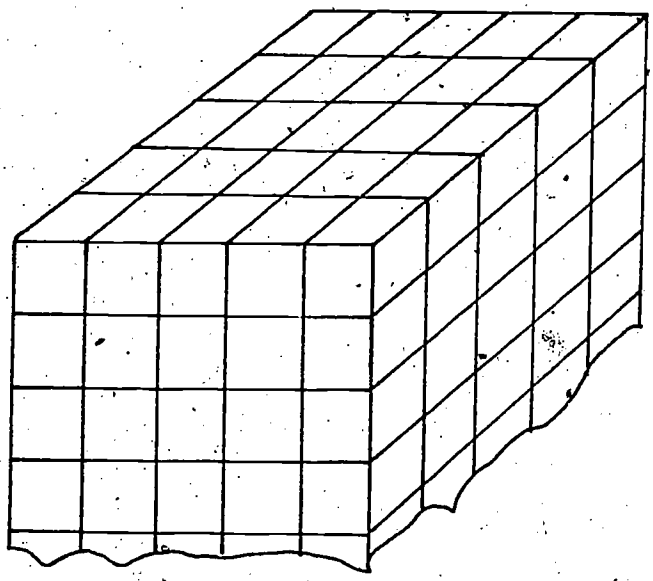
GRADE LEVEL 5

1. 87 ÷ 3 How many threes in 87?
   128 ÷ 4 How many fours in 128?

2. Susan and her Sister Sara walk to school each day. Sara knows a short cut to school. If the girls start at the same time and walk at the same speed, who will get to school first? Explain your answer.



3. Give the volume

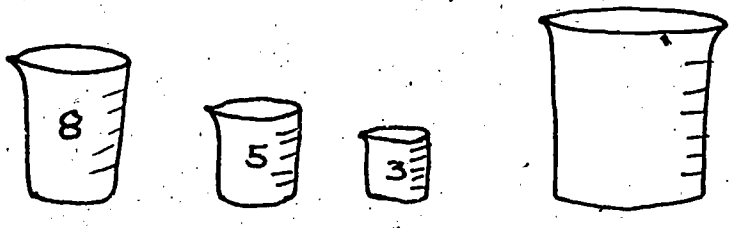


25 cubes in each layer

17 layers of cubes

V

4. How can you get 4 liters of pop from a large container if you have only containers that hold 3, 5, and 8 liters? (You can't pour any back into the large container.)



5. Joyce had to decide what to wear to school on Monday. She has 3 shirts--a red one, a navy one, and a plaid one. She has 2 pairs of slacks--a grey pair and a checkered pair. She has three sweaters--a striped one, a white one, and a yellow one. On Mondays she only wears solid colors. What are the different combinations she can wear?

V

6. Find the difference in the amounts.

(A)	(B)	(C)
$6.78	$21.95	$7.98
- 2.39	- 16.56	- 4.06

7. It cost 25 cents to use each washer and 10 cents to use each dryer in a laundromat. How much did Mrs. Jackson spend if she used two washers and three dryers?

V

8. Last night I watched a little league baseball game. I noticed some boys and dogs playing in the grass. I heard a noise and looked to see the boys and dogs running past me. I decided to count them in a different way. I counted the legs and found there were 40 of them. Now, what I want to know is how many boys and how many dogs ran past me?

9. Suppose we have a 5 by 5 geoboard. How many squares of different size can we make using rubber bands?

10. Suppose that you have a supply of 5¢ and 8¢ stamps. What amounts of postage (less than $1) can be obtained using these stamps.

11. The Jones family and their neighbors, the Smith family, are going on vacations. The two families will travel in opposite directions. If the Jones family averages 55 miles per hour and the Smith family 45 miles per hour, when will they be 750 miles apart if they start at the same time?

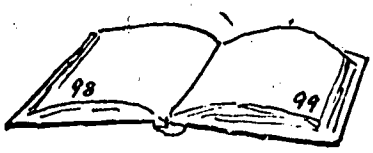
V

12. As a group project find the best answer to this situation. You are organizing a tour from New York City to Washington D.C. for your club of 100 members. You have a choice of four ways to go, private cars holding five passengers each, busses holding 50 passengers each, a two-car commuter train holding 100 passengers, and a 100 passenger airplane. You want to conserve energy so you want to select the means using the least fuel. How should you travel?

13. There is a cube block made up of 27 smaller cubes, all the same size. The outside of the cube is painted red on all of its sides. How many of the smaller cubes will be painted red on all sides? How many of the smaller cubes will be painted red on 3 sides? 2 sides? 1 side? and 0 sides?

14. There are 5 cups on the table. John has 9 marbles, and he wants to put a different number of marbles under each cup. Can he do this? Explain.

15. To number a book, 495 digits were used. How many pages in the book? How many 9's were used?



16. During one week, Miss Brown's class used 120 cartons of milk at lunch time. During the same week, Mrs. Smith's class used 132 cartons of milk, and Mrs. Frank's class used 143 cartons. How many cartons of milk did the three classes use during one week?

17. As a group project find the best answer to this situation. Your section of town has 1,000 people living in it. Estimate how much water (in gallons) is used by these people in one day (24 hours). Design a water tower to hold this one-day supply of water. Decide upon the shape (spherical, cylindrical, or something) and figure out the size.

18. Randy has a pizza pie and wants to cut the pizza pie with 5 straight cuts to get the greatest number of pieces. He knows if he cuts the pizza with one straight cut he will get at most 2 pieces. Also, he knows if he cuts the pizza with two straight cuts he will get at most 4 pieces. What is the greatest number of pieces of pizza Randy can get using 5 straight cuts?

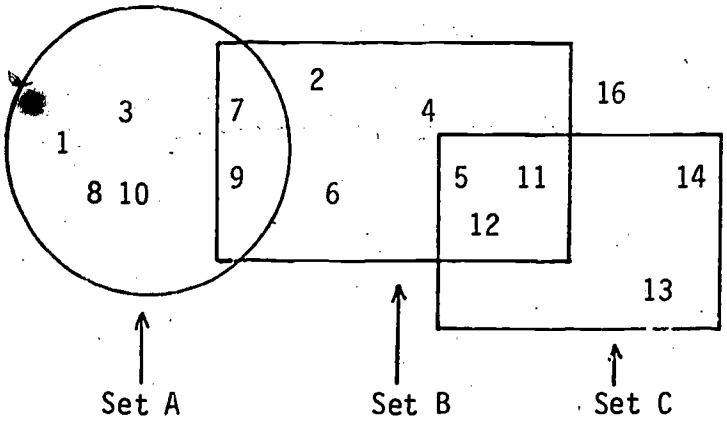
19. If you had one million dollars to give away, how long would it take giving away $100 a minute? (nearest year)

V

20. Pam helped in the school cafeteria 5 days a week for 6 weeks, so she did not have to pay for her lunch during that time. School lunches cost 38 cents. Pam's mother wants to pay her the money she saved on lunches. How much should her mother pay her?

V

21.



There are ___?___ numbers in set A.

There are ___?___ numbers in set C.

There are ___?___ numbers in A and B.

V

22. Bill's "checkers club" is planning a tournament. If there are 8 people in the club, how many games must be played in which every member plays every other member just once?

23. Your class has decided to produce a play. Before the play can be performed lines need to be learned, rehearsals held, scenery designed and produced, and costumes designed and produced. Some of these activities can be performed at the same time, but some must be performed before other activities can be done. The cast can learn the lines at the same time costumes and scenery are being designed. The costumes and scenery must be designed before either one of these can be produced. The production of the scenery and learning the lines must be done before rehearsals. The production of scenery and costumes can take place at the same time. The times needed for the various activities are:

Activity	Days
learn lines	5
design costumes and scenery	3
produce scenery	3
produce costumes	5
rehearsals	4

What is the shortest time after the play is selected that it can be performed?

V

24. Replace the ◯ with < or > or = to make each statement true.

(A) $43 \times 52 \bigcirc 52 \times 43$

(B) $15 \times 5 \times 0 \bigcirc 8 \times 5 \times 2$

(C) $9 \times (16 + 12) \bigcirc 10 \times (16 + 12)$

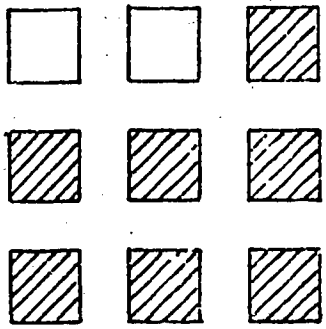
V

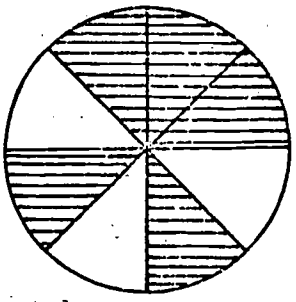
MPSP

PROBLEM DECK TO ACCOMPANY FORMS T1 AND T2

GRADE LEVEL 6

1. Write a fraction to tell what part is shaded.





VI

2. Bill's "checker club" is planning a tournament. If there are 8 people in the club, how many games must be played in which every member plays every other member just once?

3. Frank started with a number and multiplied it by 7. Then he added 75, subtracted 75 and divided by 7. Frank's answer was 19. What did Frank start with?

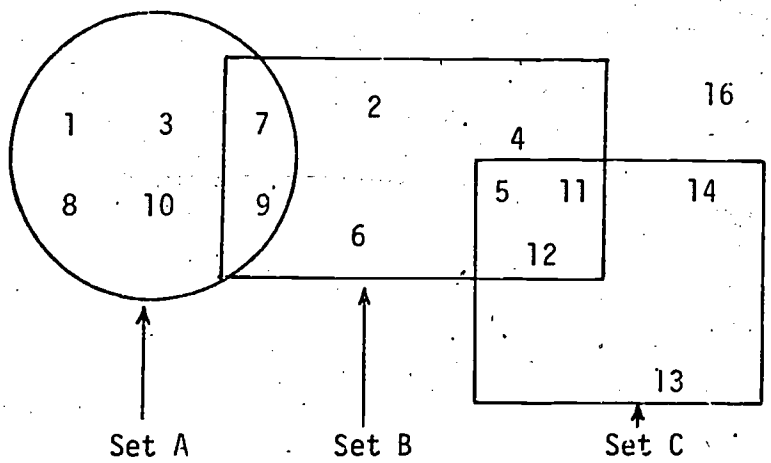
VI

Your class has decided to produce a play. Before the play can be performed lines need to be learned, rehearsals held, scenery designed and produced, and costumes designed and produced. Some of these activities can be performed at the same time, but some must be performed before other activities can be done. The cast can learn the lines at the same time costumes and scenery are being designed. The costumes and scenery must be designed before either one of these can be produced. The production of the scenery and learning the lines must be done before rehearsals. The production of scenery and costumes can take place at the same time. The times needed for the various activities are:

Activity	Days
learn lines	5
design costumes and scenery	3
produce scenery	3
produce costumes	5
rehearsals	4

What is the shortest time after the play is selected that it can be performed?

5.



There are ___?___ numbers in set A.

There are ___?___ numbers in set C.

There are ___?___ numbers in A and B.

VI

6. Tom's father works for the fire department and has every sixth night off from work. The local movie theatre is starting a "cartoon special" every fourth night. Tom's father is off from work this Sunday night. Monday night is the first "cartoon special." When (if ever) will Tom's father be able to take Tom to the cartoon special?

7. Steve reported that 10% of the cars in the parking lot are convertibles. If there are 4 convertibles in the lot, how many cars are in the parking lot?

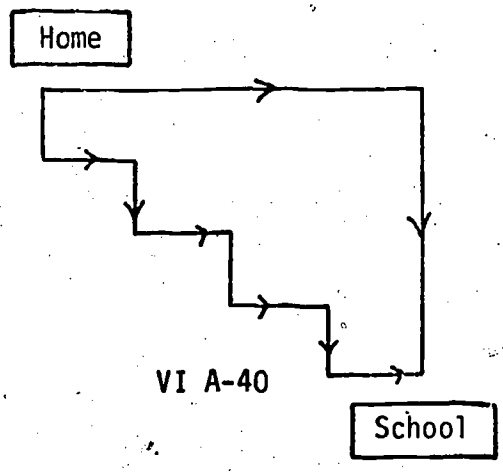
VI

8. Suppose that you have a supply of 5¢ and 8¢ stamps. What amounts of postage (less than $1) can be obtained using these stamps?

9. Every day Sally rides her bike to school along the city streets. She tries to go a different way each day. Each day she rides six blocks to school since that is the shortest way to go; she never goes out of her way.
How many days can she ride her bike to school before she has to use a path that she has already used?

VI

10. Susan and her Sister Sara walk to school each day. Sara knows a short cut to school. If the girls start at the same time and walk at the same speed, who will get to school first?
Explain your answer.



11. I have 5 pockets in my clothing: 2 in my jacket, 1 in my shirt, and 2 in my slacks. I have 81¢ in change: 5 dimes, 5 nickels, and 6 pennies. I would like to put these 16 coins in my pockets with a different number of coins in each pocket. Can I do this? I do not like to mix the different kinds of coins in the same pocket. Could I put them in my pockets without mixing any two different kinds together?

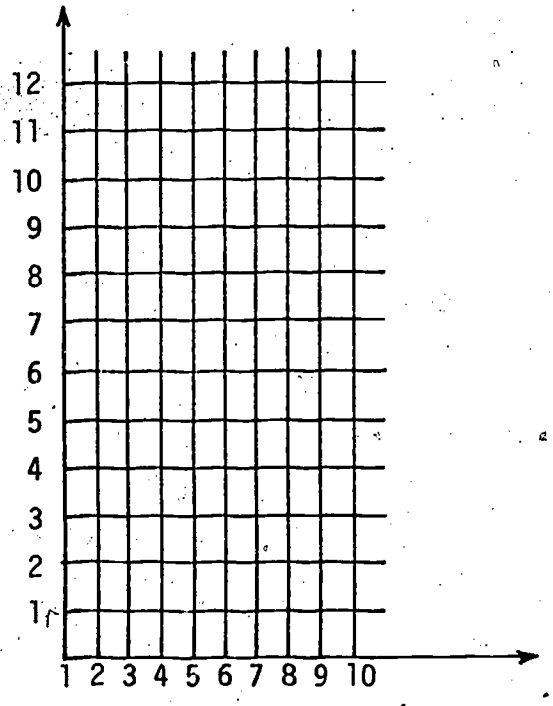
12. I'm quite close to 103, closer still to 98, yet for both numbers I am used when you want to estimate. Who am I?

13. The Moosehead Lake in Maine has an area of 116.98 square miles. The area of Lake Mead in Nevada is 228.83 square miles. Which lake has the greater area? How much greater?

VI

14. Graph each of the following points.

(3,8), (4,9), (6,10), (8,9),
(9,8), (10,6), (9,4), (8,3),
(6,2), (4,3), (3,4), (2,6)

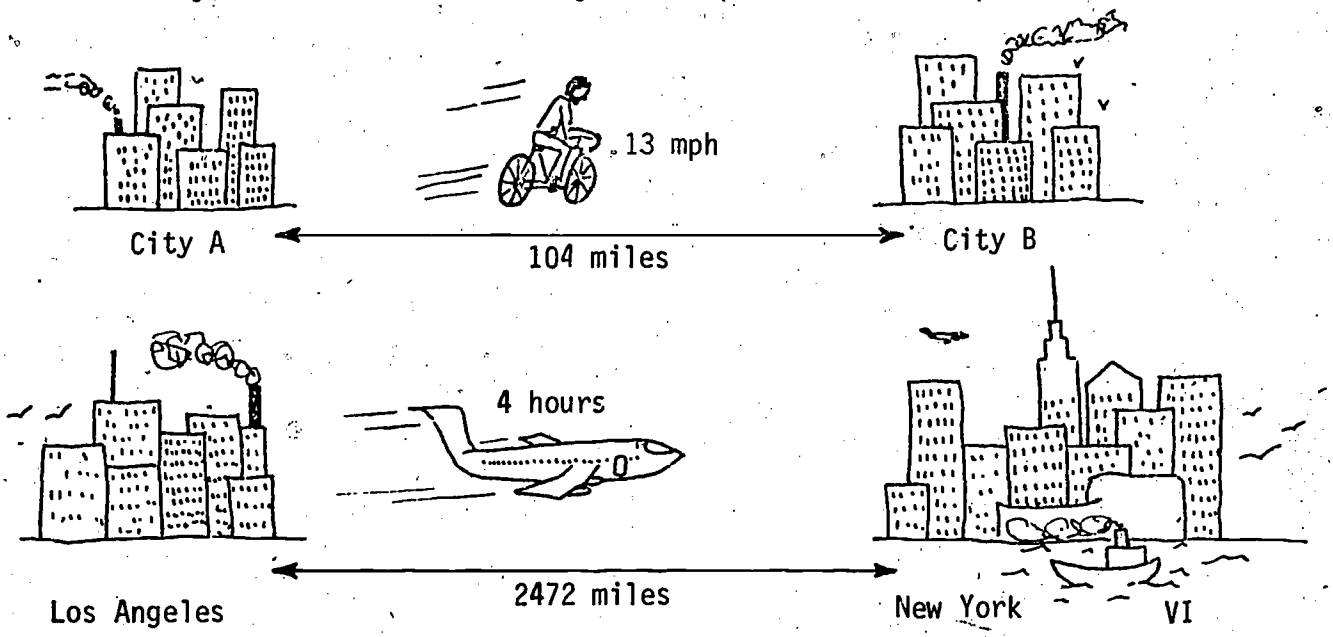


15. As a group project find the best answer to this situation. Your section of town has 1000 people living in it. Estimate how much water (in gallons) is used by these people in one day (24 hours). Design a water tower to hold this one-day supply of water. Decide upon the shape (spherical, cylindrical, or something) and figure out the size.

VI

16. In Oklahoma the highest temperature recorded was 120°F. The lowest temperature recorded was -27°F. In Alaska the highest temperature recorded was 100°F and the lowest was -76°F. Which state had the greatest change in temperature?

17. Each picture below suggests a problem. Study the picture carefully; then write and solve your own problem for the picture.



18. A special rubber ball is dropped from the top of a wall which is 16 feet high. Each time the ball bounces half as high as the distance it fell. The ball is caught when it bounces one foot high. How many times did the ball bounce?

19. Joe ran 50 yards in $\frac{1}{6}$ of a minute. Tom ran 50 yards in 12 seconds, or $\frac{?}{60}$ of a minute? Which boy ran 50 yards in less time than the other?

VI

20. As a group project find the best answer to this situation. You are organizing a tour from New York City to Washington, D.C. for your club of 100 members. You have a choice of four ways to go: private cars holding five passengers each, buses holding 50 passengers each, a two-car commuter train holding 100 passengers, and a 100 passenger air plane. You want to conserve energy so you want to select the means using the least fuel. How should you travel?

21. Which would you rather be paid? $10,000 per day for the month of November or 1¢ for the first, 2¢ for the second day, 4¢ the fourth day, 8¢ the fifth day, etc. always doubling the previous day's wages.

VI

22. Suppose we have a 3 x 3 checkerboard with 3 checkers. We want to put the checkers on the board so that there is a checker in every row and in every column.
How many other ways can we do this?

23. Find the difference in the amounts.

(A) $\begin{array}{r} \$6.78 \\ -2.39 \\ \hline \end{array}$ (B) $\begin{array}{r} \$21.95 \\ -16.56 \\ \hline \end{array}$ (C) $\begin{array}{r} \$7.98 \\ -4.06 \\ \hline \end{array}$

VI

24. There were nine boys on a baseball team. Six of the boys took special batting practice. Three other boys each took a turn pitching to the six batters. One of the boys threw left-handed, and the other two boys threw right-handed. How many ways can the batters be matched with the left-handed pitcher?

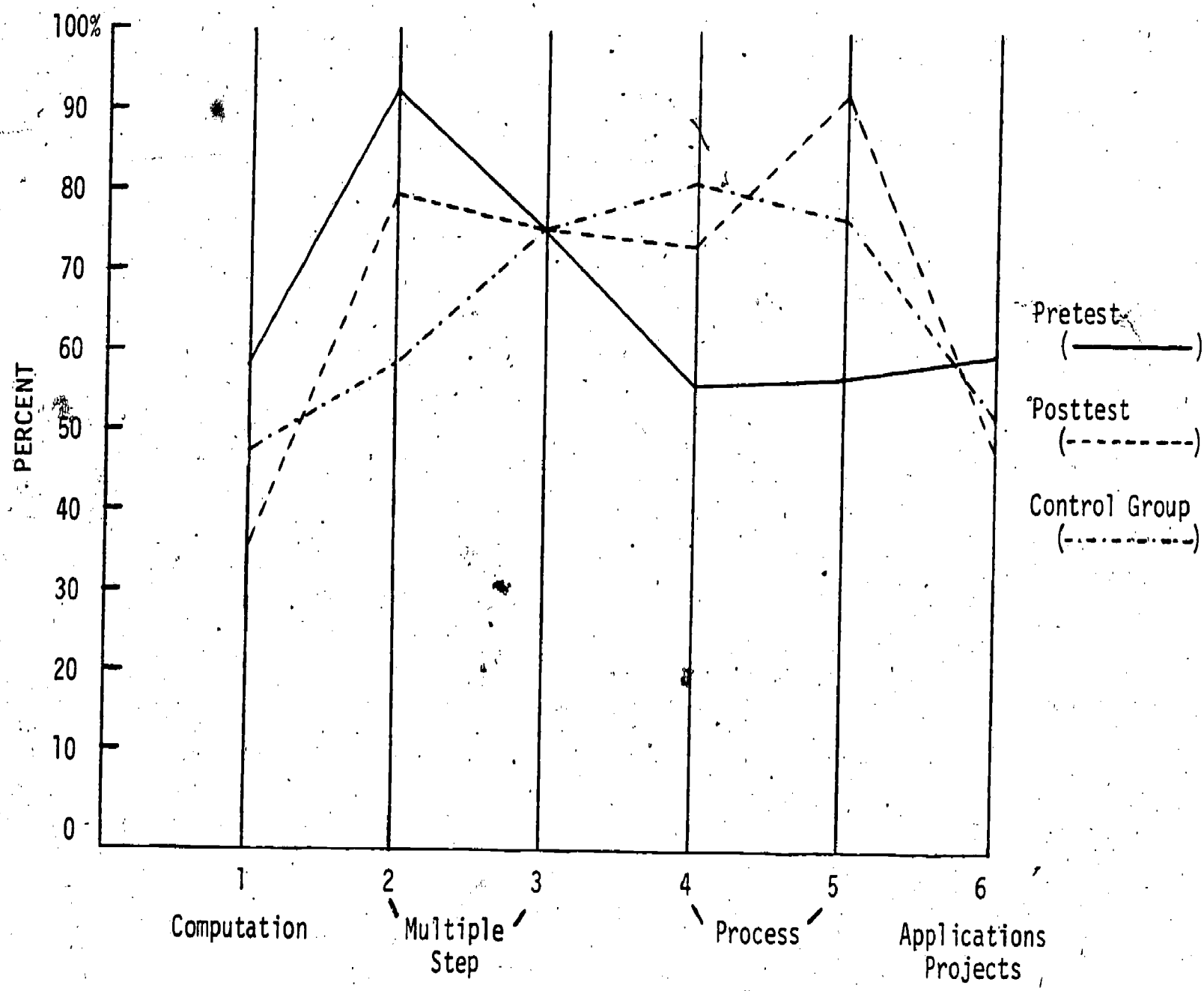
APPENDIX B

Teacher Problem Sort Task

Percent of Problems Selected Within Each Category That Would Be Used in Teaching Problem Solving

PERCENT OF PROBLEMS SELECTED WITHIN EACH CATEGORY THAT WOULD BE USED IN TEACHING PROBLEM SOLVING

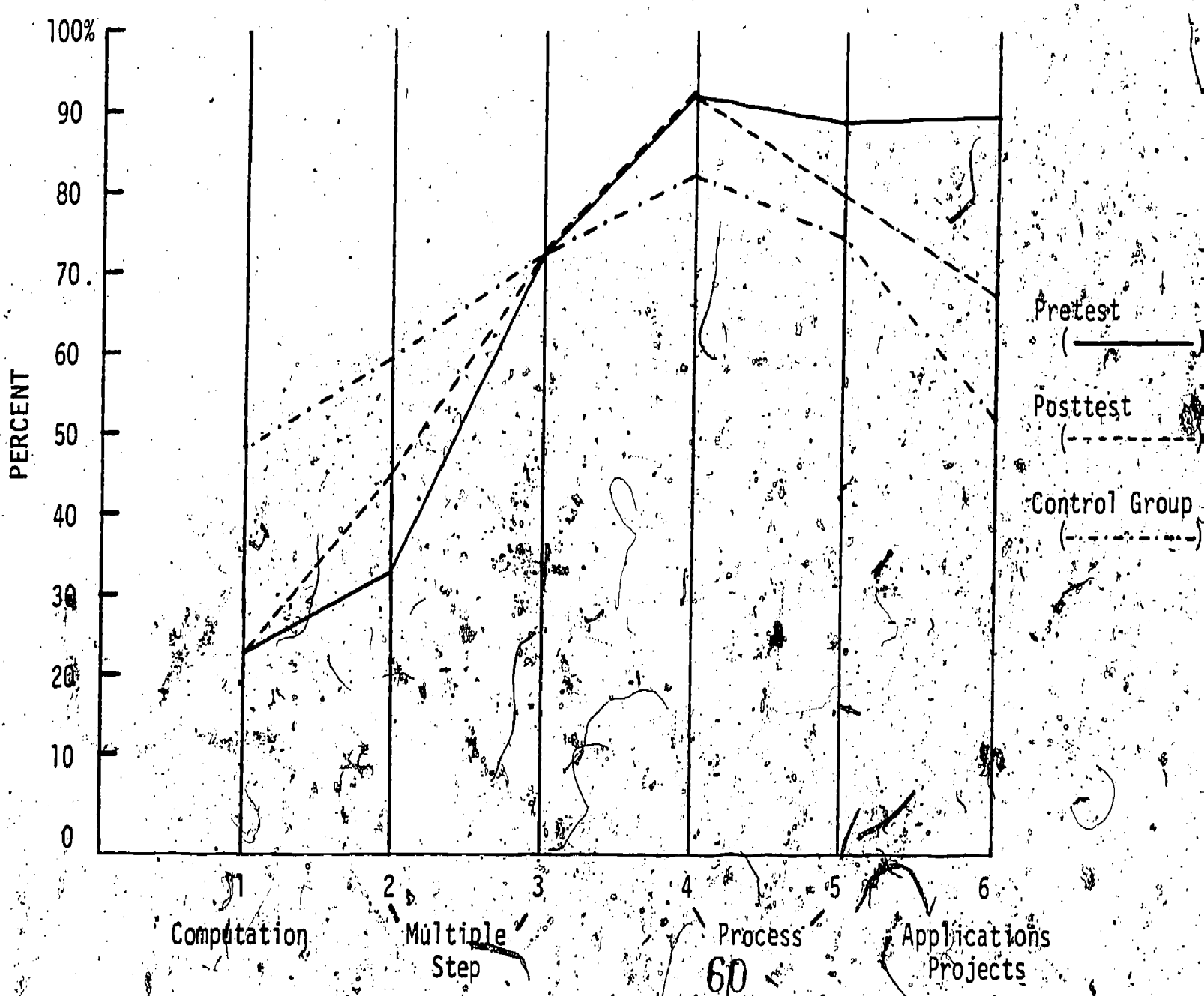
Problem Sort Task - Form T1
Teacher Groups 12 and 13 (N = 12)
, and Control Teachers (N = 11)



(Figure 1)

PERCENT OF PROBLEMS SELECTED WITHIN EACH CATEGORY THAT WOULD BE USED IN TEACHING PROBLEM SOLVING

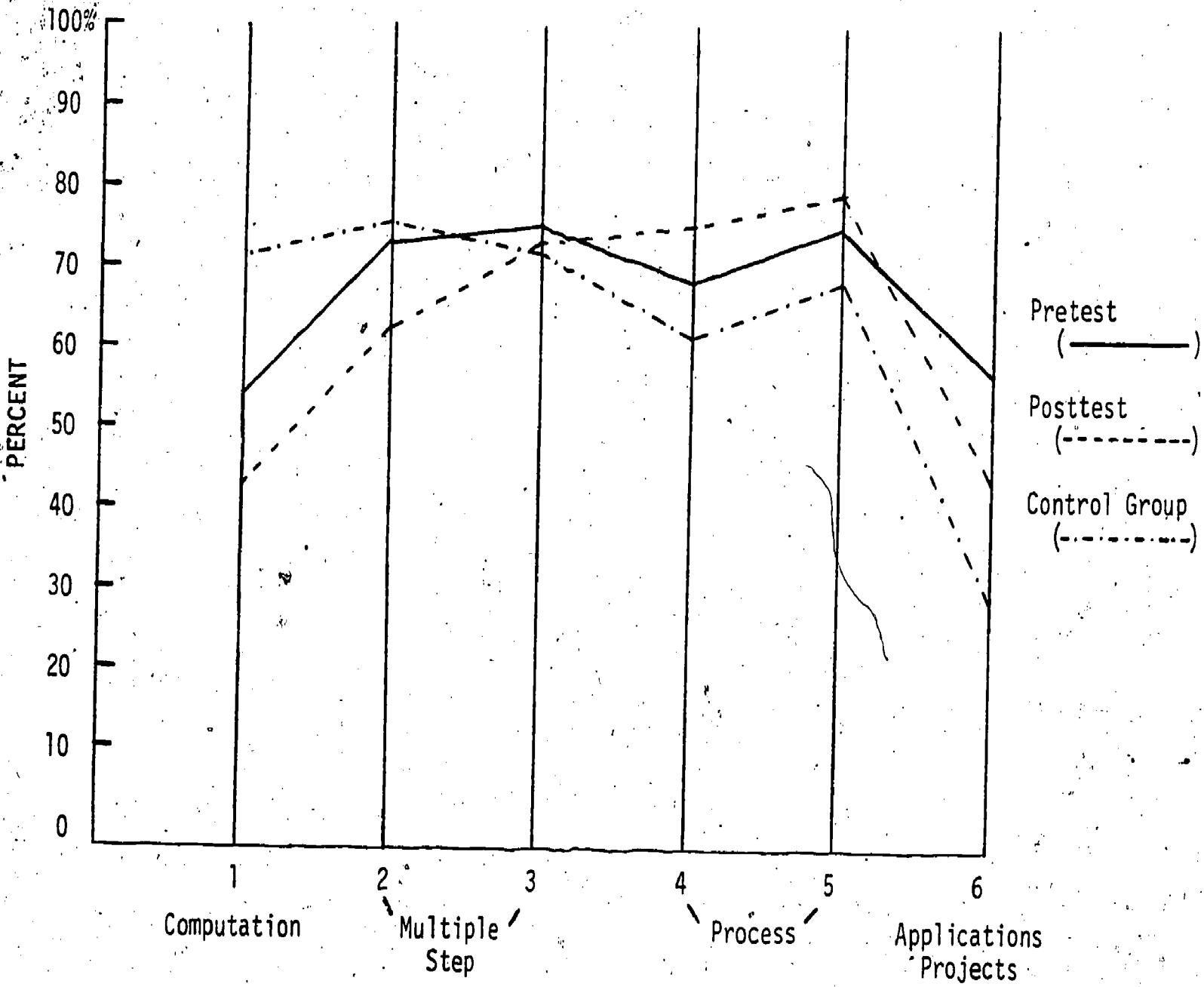
Problem Sort Task - Form T1
Teacher Group 11 (N = 5)
and Control Teachers (N = 11)



(Figure 2)

PERCENT OF PROBLEMS SELECTED WITHIN EACH CATEGORY THAT WOULD BE USED IN TEACHING PROBLEM SOLVING

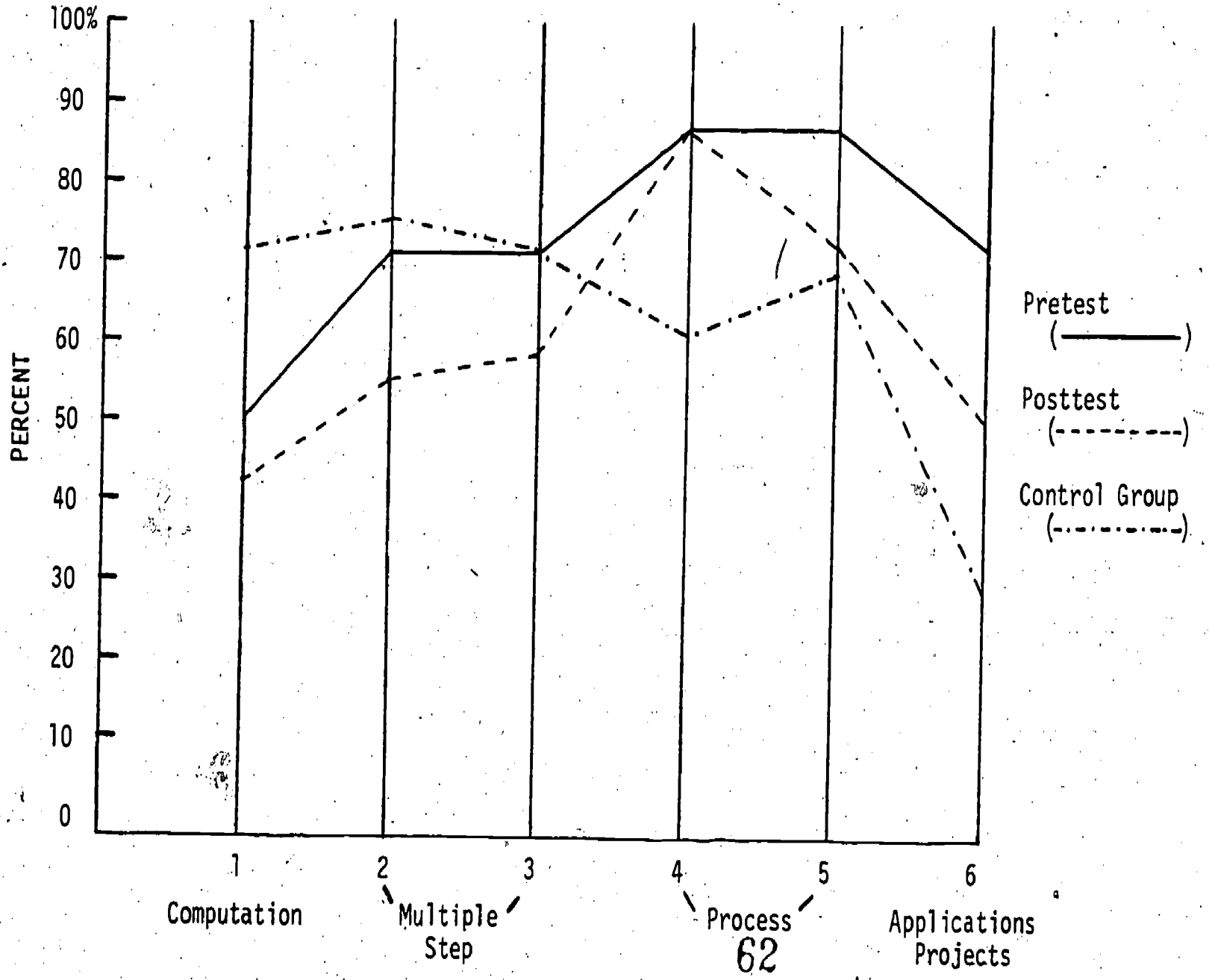
Problem Sort Task - Form T2
Teacher Groups 12 and 13 (N = 15)
and Control Teachers (N = 7)



(Figure 3)

PERCENT OF PROBLEMS SELECTED WITHIN EACH CATEGORY THAT WOULD BE USED IN TEACHING PROBLEM SOLVING

Problem Sort Task - Form T2
Teacher Group 11 (N = 6)
and Control Teachers (N = 7)



(Figure 4)

APPENDIX C

Teacher Problem Sort Task

Frequency of Teachers Selecting Each Problem by Category

Table 1

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Pre-Post Grade 4 - Experimental Teacher Group
(N = 5)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	9	14		
	Pre	1	1	1	4	7	.35
	Post	0	0	0	3	3	.15
2		3	6	7	11		
	Pre	5	4	5	4	18	.90
	Post	3	3	4	5	15	.75
3		12	17	21	24		
	Pre	3	3	4	4	14	.70
	Post	2	4	5	5	16	.80
4		15	18	20	23		
	Pre	5	2	2	2	11	.55
	Post	4	1	4	4	13	.65
5		2	10	16	22		
	Pre	2	3	3	4	12	.60
	Post	5	5	5	5	20	1.00
6		4	8	13	19		
	Pre	2	4	4	5	15	.75
	Post	2	5	3	1	11	.55

Table 2

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Pre-Post Grade 5 - Experimental Teacher Groups
Old - (N = 2) New - (N = 4)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	6	21	24		
	Pre Old*	0	0	2	1	3	.375
	Pre New**	3	1	2	6	12	.75
	Post Old	0	0	1	0	1	.125
	Post New	3	3	3	3	12	.75
2		3	7	16	20		
	Pre Old	1	1	1	2	5	.625
	Pre New	3	3	3	6	15	.938
	Post Old	1	2	0	1	4	.50
	Post New	4	4	4	4	16	1.00
3		2	11	15	19		
	Pre Old	2	1	2	2	7	.875
	Pre New	1	3	2	7	13	.8125
	Post Old	2	2	2	2	8	1.00
	Post New	3	3	3	4	13	.8125
4		5	9	13	22		
	Pre Old	2	2	1	2	7	.875
	Pre New	1	3	2	3	9	.563
	Post Old	2	2	2	2	8	1.00
	Post New	2	4	2	3	11	.688
5		4	8	14	18		
	Pre Old	2	2	2	2	8	1.00
	Pre New	0	0	2	6	8	.50
	Post Old	1	1	2	2	6	.75
	Post New	3	3	4	4	14	.875

Table 2 (cont.)

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Pre-Post Grade 5 - Experimental Teacher Groups
Old - (N = 2) New - (N = 4)

Category	When Administered	Problem # / Frequency				Total	Index
		10	12	17	23		
6	Pre Old	2	1	2	2	7	.875
	Pre New	3	1	3	1	8	.50
	Post Old	2	2	0	1	5	.625
	Post New	4	2	0	0	6	.375

* Old refers to teacher group 11.

** New refers to teacher groups 12 and 13.

Table 3

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Pre-Post Grade 6 - Experimental Teacher Groups
Old - (N = 3) New - (N = 3)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	14	23		
	Pre Old	0	1	1	0	2	.167
	Pre New	3	3	1	2	9	.75
	Post Old	1	1	1	1	4	.33
	Post New	0	1	1	0	2	.167
2		3	7	13	16		
	Pre Old	2	2	0	2	6	.50
	Pre New	3	2	3	3	11	.917
	Post Old	1	1	1	2	5	.417
	Post New	2	2	1	2	7	.583
3		10	12	17	19		
	Pre Old	1	2	1	4	8	.67
	Pre New	2	2	3	2	9	.75
	Post Old	2	1	2	2	7	.583
	Post New	2	0	3	2	7	.583
4		2	18	21	24		
	Pre Old	2	2	2	6	12	1.00
	Pre New	2	1	2	2	7	.583
	Post Old	3	3	3	2	11	.917
	Post New	3	3	2	3	11	.917
5		6	9	11	22		
	Pre Old	1	1	2	6	10	.833
	Pre New	2	1	3	2	8	.67
	Post Old	1	3	3	3	10	.83
	Post New	3	2	3	2	10	.83

Table 3 (cont.)

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Pre-Post Grade 6 - Experimental Teacher Groups
Old - (N = 3) New - (N = 3)

Category	When Administered	Problem # / Frequency				Total	Index
		4	8	15	20		
6	Pre Old	2	2	2	5	11	.917
	Pre New	1	3	1	1	6	.50
	Post Old	1	3	2	3	9	.75
	Post New	2	2	1	1	6	.50

Table 4

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Grade 4 - Control Teacher Group
(N = 4)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	9	14		
	Post	1	1	1	3	6	.375
2		3	6	7	11		
	Post	2	2	3	2	9	.5625
3		12	17	21	24		
	Post	3	3	3	4	13	.8125
4		15	18	20	23		
	Post	4	3	4	3	14	.875
5		2	10	16	22		
	Post	3	3	2	3	11	.6875
6		4	8	13	19		
	Post	2	2	2	2	8	.50

Table 5

FREQUENCY OF TEACHERS SELECTING EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Grade 5 - Control Teacher Group
(N = 2)

Category	When Administered	Problem # / Frequency	Total	Index
1		1 6 21 24		
	Post	1 1 1 0	3	.375
2		3 7 16 20		
	Post	1 0 1 1	3	.375
3		2 11 15 19		
	Post	0 1 1 1	3	.375
4		5 9 13 22		
	Post	0 2 2 2	6	.75
5		4 8 14 18		
	Post	2 2 2 2	8	1.00
6		0 12 17 23		
	Post	0 1 2 1	4	.50

Table 6

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T1 - Would Use in Teaching Problem Solving

Grade 6 - Control Teacher Group
(N = 4)

Category	When Administered	Problem #				Total	Index
		Frequency					
1		1	5	14	23		
		3	2	3	1	9	.5625
2		3	7	13	16		
		3	3	2	2	10	.625
3		10	12	17	19		
		3	1	4	3	11	.6875
4		2	18	21	24		
		4	3	4	3	14	.875
5		6	9	11	22		
		4	3	3	3	13	.8125
6		4	8	15	20		
		2	4	1	2	9	.5625

Table 7

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Pre-Post Grade 4 - Experimental Teacher Group
(N = 6)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	9	14		
	Pre	3	3	3	4	13	.542
	Post	3	2	2	5	12	.50
2		3	6	7	11		
	Pre	6	4	5	4	19	.792
	Post	5	4	6	3	18	.75
3		12	17	21	24		
	Pre	3	4	3	5	15	.625
	Post	3	5	5	4	17	.708
4		15	18	20	23		
	Pre	5	2	3	3	13	.542
	Post	4	2	5	4	15	.625
5		2	10	16	22		
	Pre	4	4	6	6	20	.833
	Post	2	6	5	6	19	.792
6		4	8	13	19		
	Pre	2	3	3	3	11	.458
	Post	1	6	1	2	10	.417

Table 8

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Pre-Post Grade 5 - Experimental Teacher Groups
Old - (N = 2) New - (N = 5)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	6	21	24		
	Pre Old	0	2	2	0	4	.50
	Pre New	3	1	3	4	11	.55
	Post Old	0	0	2	0	2	.25
	Post New	0	1	3	1	5	.25
2		3	7	16	20		
	Pre Old	0	2	2	2	6	.75
	Pre New	0	3	3	8	14	.70
	Post Old	1	1	1	2	5	.625
	Post New	3	3	3	4	13	.65
3		2	11	15	19		
	Pre Old	2	0	2	2	6	.75
	Pre New	3	5	2	8	18	.90
	Post Old	2	0	1	2	5	.625
	Post New	5	3	3	5	16	.80
4		5	9	13	22		
	Pre Old	2	1	1	2	6	.75
	Pre New	2	3	3	5	13	.65
	Post Old	2	1	2	1	6	.75
	Post New	4	5	3	4	16	.80
5		4	8	14	18		
	Pre Old	1	2	2	2	7	.875
	Pre New	3	3	4	5	15	.75
	Post Old	1	1	2	2	6	.75
	Post New	4	4	5	5	18	.90

Table 8 (cont.)

FREQUENCY OF TEACHERS SELECTING EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Pre-Post Grade 5 - Experimental Teacher Groups
Old - (N = 2) New - (N = 5)

Category	When Administered	Problem # / Frequency				Total	Index
		10	12	17	23		
6	Pre Old	2	0	1	2	5	.625
	Pre New	3	1	3	3	10	.50
	Post Old	2	0	1	0	3	.375
	Post New	3	2	1	1	7	.35

Table 9

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Pre-Post Grade 6 - Experimental Teacher Groups
Old - (N = 4) New - (N = 4)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	14	23		
	Pre Old	2	2	3	1	8	.50
	Pre New	2	2	2	2	8	.50
	Post Old	2	2	3	1	8	.50
	Post New	2	1	4	1	8	.50
2		3	7	13	16		
	Pre Old	3	3	2	3	11	.688
	Pre New	2	1	3	5	11	.688
	Post Old	2	2	2	2	8	.50
	Post New	3	1	1	2	7	.438
3		10	12	17	19		
	Pre Old	3	2	3	3	11	.688
	Pre New	2	2	2	6	12	.75
	Post Old	4	2	1	2	9	.563
	Post New	4	3	2	2	11	.688
4		2	18	21	24		
	Pre Old	3	3	3	6	15	.938
	Pre New	3	3	3	6	15	.938
	Post Old	4	4	4	3	15	.938
	Post New	4	4	4	2	14	.875
5		6	9	11	22		
	Pre Old	2	2	3	7	14	.875
	Pre New	1	1	2	6	10	.625
	Post Old	1	3	4	3	11	.688
	Post New	3	2	3	2	10	.625

Table 9 (cont.)

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Pre-Post Grade 6 - Experimental Teacher Groups
Old - (N = 4) New - (N - 4)

Category	When Administered	Problem #				Total	Index
		Frequency					
6		4	8	15	20		
	Pre Old	1	3	3	5	12	.75
	Pre New	2	3	2	6	13	.813
	Post Old	0	3	3	3	9	.563
	Post New	1	2	4	2	9	.563

Table 10

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Grade 4 - Control Teacher Group
(N = 3)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	9	14		
	Post	3	3	3	3	12	1.00
2		3	6	7	11		
	Post	2	3	3	2	10	.833
3		12	17	21	24		
	Post	2	3	2	3	10	.833
4		15	18	20	23		
	Post	2	2	3	2	9	.75
5		2	10	16	22		
	Post	3	1	3	3	10	.833
6		4	8	13	19		
	Post	1	2	1	0	4	.333

Table 11

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Grade 5 - Control Teacher Group
(N = 2)

Category	When Administered	Problem #				Total	Index
		Frequency					
1		1	6	21	24		
	Post	0	1	2	2	5	.625
2		3	7	16	20		
	Post	0	1	2	2	5	.625
3		2	11	15	19		
	Post	2	0	2	2	6	.75
4		5	9	13	22		
	Post	2	0	1	1	4	.50
5		4	8	14	18		
	Post	1	1	2	2	6	.75
6		10	12	17	23		
	Post	1	2	0	1	4	.50

Table 12

FREQUENCY OF TEACHERS SELECTING
EACH PROBLEM BY CATEGORY

FORM T2 - Would Use in Teaching Problem Solving

Grade 6 - Control Teacher Group
(N = 2)

Category	When Administered	Problem # / Frequency				Total	Index
1		1	5	14	23		
	Post	1	0	1	1	3	.375
2		3	7	13	16		
	Post	1	2	1	2	6	.75
3		10	12	17	19		
	Post	1	1	1	1	4	.50
4		2	18	21	24		
	Post	1	1	1	1	4	.50
5		6	9	11	22		
	Post	1	1	0	1	3	.375
6		4	8	15	20		
	Post	0	0	0	0	0	.00